Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of the Commission's	)	
Rules and Policies to Increase	)	CC Docket No. 95-115
Subscribership and Usage of	)	
the Public Switched Network	)	
	)	

COMMENTS OF SPRINT CORPORATION

To: The Commission

Sprint Corporation ("Sprint") submits its initial comments in the above captioned Notice of Proposed Rulemaking (NPRM). As a corporation whose different subsidiaries provide local exchange, interexchange, and wireless communications, Sprint believes it is uniquely situated to provide valuable insights into the important questions the Commission has raised.

SUMMARY

Sprint believes that the public as well as telephone companies benefit from increased subscribership to the public switched network. Telephone companies derive no revenue from a disconnected customer, and so have every incentive to try to keep a customer on the network if at all possible. With increasing competition in all aspects of the communications business, all communications companies will

have to work harder to attract and retain customers even without Commission intervention.

Several of the Commission's proposals to increase telephone subscribership are likely to impose significant costs on the industry while not increasing subscribership in any material fashion. It is unclear that existing regulatory policies forbidding disconnect for nonpayment of toll contribute to telephone subscribership in any material way. Such policies, however, already impose heavy burdens on the industry.

The Commission's proposal to forbid disconnect for nonpayment of interstate toll charges is likely to be ineffective so long as customers can still be disconnected for nonpayment of intrastate toll charges. Moreover, even uniform application of rules forbidding disconnect for nonpayment is likely to raise telephone company uncollectibles, cause closer scrutiny of prospective customers, force telephone companies to screen such customers more carefully, and possibly grant service more sparingly.

There is already a broad range of formal and informal industry practices in effect today aimed at keeping customers on the network while not exposing telephone companies to undue credit risk. These include inexpensive toll restriction service, the availability of prepaid

calling cards, and adjustments and accommodations with respect to deposits and time payment plans which are often made on an informal, case-by-case basis. The Commission should not enact additional regulations until it satisfies itself that these existing practices are inadequate.

COMMENTS

Sprint commends the Commission for its interest in maximizing the public's access to telecommunications services. Such a policy is consistent with Congress's purpose in adopting the Communications Act. Sprint urges the Commission to move cautiously and deliberately, however, since some of the Commission's proposals may have unintended consequences, may impose significant administrative and technical burdens on the industry, and may disrupt long-standing formal and informal mechanisms already aimed at resolving the very problems perceived by the Commission in the NPRM.

By way of background, Sprint believes that all communications providers have an economic incentive to maximize the number of subscribers on the public switched telephone network. A subscriber who drops telephone service is not only a lost customer, but also a subscriber who cannot be reached by other subscribers to telephone service, thereby reducing the utility of that service to those other subscribers.

As competition in all aspects of telecommunications increases, Sprint expects that all competitors will have to do even more to acquire and retain customers. With increased competition it should be less necessary for the Commission to mandate what competitive forces are likely to produce on their own.

In Sprint's experience, the telecommunications industry already formally and informally attempts to ensure that subscribers can get on and stay on the network. Sprint believes that many of these methods, discussed further below, are working effectively. They have existed for many years and could be disrupted by precipitous action on the Commission's part. Sprint therefore urges the Commission to proceed carefully.

Many of the Commission's proposals would also impose significant new burdens on the industry with little or no assurance that subscribership would be increased. Sprint also believes that some of the Commission's assumptions, such as those regarding the relationship between subscribership and disconnect for nonpayment policies, may not be entirely correct. At least one recent study[1] has found that gains in penetration become more and more

[1] Albery, "What Level of Dialtone Penetration Constitutes 'Universal Service,' Telecommunications Policy, Vol. 19, No. 5, pp. 365-380 at 368 (1995) ("Albery Study"). A copy of the Albery Study is attached to these Comments.

difficult to achieve as penetration approaches 100%.[2] Sprint therefore urges the Commission to reexamine its initial analysis to ensure that the industry is not required to bear the cost of changes without achieving corresponding increases in subscribership. Sprint's specific areas of concern are discussed below.

I. Disconnect for Nonpayment (DNP)

Sprint believes that the Commission's proposals to forbid DNP of interstate toll have both theoretical and practical drawbacks. And from a policy standpoint, Sprint is troubled by the Commission's apparent underlying assumption that because customers cannot control their own long distance usage, regulators must assist them in doing so through DNP rules. Sprint believes that many individuals would find this attitude patronizing: subscribers to telephone service are presumably adults who understand and are responsible for the consequences of their actions.

In the NPRM, the Commission expressed its belief that Pennsylvania's policy of forbidding DNP of long distance

[2] As the Albery Study explained by way of example, "assume that all households without telephones can be grouped into two classifications: households that cannot afford telephones and households practicing a religion that prohibits telephones. The first group could be cajoled into purchasing telephone service if the proper assistance programs are established or the group's personal incomes grow to the point where telephone service becomes financially feasible. The second group, however, probably cannot be cajoled into subscribing to telephone service regardless of changes in price, personal income or any factor used to predict telephone subscribership behavior. As in a classic example of diminishing returns, the closer a state's penetration level is to 100%, the less response the state is likely to get through programs to promote telephone subscription." Albery Study at 368.

charges contributes to Pennsylvania's leading all other states in overall subscribership. Sprint also notes, however, the real possibility that other variables may be responsible for this result.

The Commission's own August 1, 1995 report on Telephone Subscribership in the United States (the "Study") reveals that other states -- states which the Commission identified as not forbidding DNP -- (e.g. Virginia (98.0%), Wisconsin (98.4%) and Utah (98.2%)) have higher overall penetration rates than does Pennsylvania (97.6%). The Commission has previously found a strong relationship between income and penetration.[3] The Albery Study[4] similarly concluded that

> Disposable Income is an excellent variable for explaining differences in penetration levels between states. State data show a very high correlation between state average personal income and statewide penetration rates. States with low personal income relative to national averages also have low penetration levels.

Albery Study at 375. Such differences may be responsible for differences in penetration.[5]

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[3] August 1, 1995 Study at 4.

[4] See n. 1, supra.

[5] The Commission also thought that Pennsylvania's DNP policies accounted for the 92.3% penetration in Pennsylvania among households with incomes less than $10,000 as compared with 87.4% penetration nationwide. The August, 1995 Study does not break down subscribership by income. Sprint notes, however, that the Study's Table 4 indicates there has been relatively little variation in telephone subscribership by households with annual income under $5000 between November 1983 (78.4%) and March 1995 (79.4%) even though income levels have not been adjusted for inflation. Since it therefore appears possible that such households have maintained their level of telephone subscribership notwithstanding a decline in real income, the Commission should examine more closely the complex relationships between geographic location, household income, and telephone subscribership before issuing new regulations.

Even if the Commission could be more certain that subscribership would increase if DNP were forbidden, there are a number of serious drawbacks to the Commission's DNP proposal. For example, it proposes to forbid DNP only in the case of unpaid bills for interstate communication. Presumably, a subscriber could still fail to pay his or her intrastate toll bills and become totally disconnected.[6] Thus, the Commission's proposal is unlikely to fully achieve its goal of retaining and increasing subscribership and raises serious questions whether it would increase subscribership in any significant manner, or at all.

Even a uniform policy forbidding DNP in the case of both intrastate/interstate toll is likely to increase credit risk for telephone companies of all stripes. Sprint's Long Distance Division is aware of individuals who currently take advantage of a state's policy forbidding DNP of toll charges by running up a substantial bill with one long distance carrier, not paying, then switching to another such carrier. This process can be repeated many times, visiting losses on multiple carriers.

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[6] The NPRM does not address the difficult jurisdictional issues that would arise if a state permitted DNP for nonpayment of intrastate toll but the Commission forbade DNP for nonpayment of interstate toll. Unless the Commission preempted all DNP practices, a subscriber who fails to pay for both intra and interstate toll calls (a likely scenario since most subscribers do not differentiate between them) would be totally disconnected. The Commission's NPRM, however, does not afford sufficient notice to enable the Commission effectively to pre-empt state practices on DNP. See McElroy Electronics Corp. v. FCC, 990 F.2d 1351 (D.C. Cir. 1993).

Presumably, the Commission has no intention of forcing carriers to serve those who have proven to be uncreditworthy or to take undue financial risk with prospective customers who have no credit history. In order to avoid significant uncollectibles, however, and charging such expenses to shareholders or other ratepayers (there are no other sources), the industry may find it necessary to refuse service to those of demonstrated uncreditworthiness or to grant service to those of uncertain creditworthiness only if a sufficient deposit is made. In such cases, even a uniform policy forbidding DNP for both intra and interstate toll may work at cross-purposes with the Commission's goals of increasing subscribership.

While the ability to disconnect for nonpayment is a useful collection tool, it bears repeating that in Sprint's experience, telephone companies do not go around trying to find excuses to disconnect customers for nonpayment: there is no economic incentive to do so except under circumstances where the subscriber has by his or her own actions demonstrated the need for this drastic course. Sprint's own policy is to try to work with customers who are willing but unable to pay their bills by establishing informal time payment plans.

Moreover, there are long-standing formal and informal useful practices by which telephone companies and others

seek to maximize their customer base while protecting against undue credit risk. In one instance of which Sprint is aware, members of an informal association of utilities share information about their credit experiences with their customers so that more potential customers can obtain service without the need for a deposit.

Similarly, some local telephone companies will informally share information about their customer who has moved into a second local company's service territory upon request by the second company. A prospective customer with a favorable credit history will not have to make a deposit or only a small deposit. Other local telephone companies permit a customer who is known to them to guarantee payment by a new customer lacking a credit history, thus avoiding the need for a substantial deposit.

In light of the above, the Commission should, in its quest to increase subscribership, move with care before imposing what have turned out to be costly, burdensome and ineffective requirements in state jurisdictions which have adopted similar policies. The proposed regulation of telephone company deposit standards, for example, may be unnecessary because existing practices already serve the Commission's goals. Moreover, a number of states already regulate deposit practices closely, raising the possibility of conflicts between the federal and state jurisdictions or

at least the need to preempt. Unless the Commission finds existing deposit practices inadequate, Sprint questions whether additional requirements would have any material effect on subscribership.

A uniform, nationwide rule forbidding DNP for both intrastate and interstate toll would also give rise in some instances to difficult practical questions with competitive implications. Assume, as is not uncommon, that a particular local exchange carrier provides both local service and intrastate intraLATA toll, with interLATA and interstate toll provided by an interexchange carrier. Assume further that the customer does not pay his or her toll bill but maintains local service. Later, the customer seeks to make partial payment in the hopes of reinstituting long distance service.

In states that do not already regulate partial payment practices, should the partial payment be denied, with the customer's service continuing to be restricted? If partial payment is accepted, should the interexchange carrier be paid first or the local exchange carrier? If both, should the payment be proportional to the amounts owed each carrier or split equally? Will the Commission prescribe the nature of such arrangements or hope for the best? What ongoing administrative costs would have to be incurred to implement and oversee such partial payment practices, particularly

with more and more states opening intraLATA toll to competition?

In New York, which has already implemented partial payment rules, Sprint has found the administrative burdens considerable as those rules require a complex allocation of partial payments among several carriers and services.

Sprint's experience with the burden of partial payment rules is consistent with its general experience that the administration of regulations concerning DNP practices is burdensome and increases to subscribership minimal. In New York, for example, when a DNP customer approaches Sprint and requests service, Sprint is required by regulators to offer them an opportunity to reconnect if deposit arrangements are made. After spending approximately $32,000 annually for postage and personnel alone, Sprint has found that extremely few customers are willing or able to accept the offer.

A uniform, nationwide rule forbidding DNP for both intrastate and interstate toll would also present technical difficulties as well. While it may be possible to block only interstate toll service, this does not mean that it can be done cheaply and quickly notwithstanding the Commission's belief that it is now practical. (NPRM at para. 29)

In areas where local exchange service covers multiple states, calls between numbers with different NPAs or area codes, such as within the metropolitan Washington, D.C.

area, can be interstate toll calls or local calls. All switches in such areas would have to be reprogrammed to recognize the difference between such calls to avoid DNP in the event of nonpayment of interstate toll charges while still maintaining local service. It is Sprint's understanding that this would be a lengthy and costly effort requiring switch manufacturers to write new software.

In a similar vein, Sprint's Long Distance Division, in passing call data back to local exchange carriers electronically, does not differentiate between intrastate and interstate toll calls. A rule forbidding DNP with respect to interstate toll only would require a costly revamp of internal signaling systems so that they could differentiate between interstate and intrastate toll.

II. Voluntary Toll Restriction Services

The Commission seeks comment on requiring telephone companies to provide low-cost voluntary toll restriction services. Sprint sees a number of drawbacks to the Commission's proposals. For example, the Commission envisions a long-distance blocking service that would block only those interstate calls for which the subscriber would be charged. NPRM at para. 17. Here again, however, Sprint questions the efficacy of a toll blocking service that applies only to interstate calls. Since most customers do not distinguish between intra and interstate toll, a

customer who does not pay his or her intrastate toll bill could still become totally disconnected for nonpayment of those charges.

Sprint also observes that most of its local exchange carriers already offer low cost toll restriction services under their local tariffs, typically for a recurring charge of $2 or $3 per month. These services have not necessarily come about because of regulatory requirements: many businesses, for example, do not wish their employees to be able to make toll calls or otherwise impose liability for toll charges on the employer.

The telephone industry has attempted to be responsive to these concerns. As competition in local telephone services increases, Sprint expects that all competitors will have to become even more responsive to customer needs and desires. Thus, it should be less necessary for the Commission to require what competitive forces are likely to produce on their own.

III. Other Issues

Sprint believes that in many cases, options already exist that would assist people in connecting to the public switched network but there is inadequate knowledge of their existence. In some states, for example, information on Lifeline and Link-Up assistance is given to applicants for public assistance as part of an informational package. This

practice is not universal, however, and the Commission could take steps to encourage the further dissemination of this information.

Prepaid calling cards, which are now widely available, allow customers who are toll restricted or mobile to make long distance calls in spite of toll restriction and without any permanent connection to the network at all. Such cards also enable customers to make long distance calls while controlling these expenditures closely.

The need to reach those who are highly mobile can also be met in part, at least, by low cost mobile services currently available in the marketplace. Wide area paging services are now available which, when coupled with available voicemail, enable a person on the move to receive messages and return calls promptly from public telephones. Although not a perfect substitute for telephone service, such capability is much less costly (approximately $11 a month for up to 400 pages a month in one large metropolitan area with which Sprint is familiar) than cellular service. It is also much better than being unreachable.

Again, it may be that those who could use such a service are not aware of its wide availability and relatively low cost. But it is unclear to Sprint why local telephone companies, which may not even offer paging service, should be tasked with advertising or otherwise

making the public aware of such service as the Commission proposes in the NPRM.

CONCLUSION

The Commission's NPRM raises important and far reaching issues of social policy with potentially significant impact on the telephone industry. Sprint urges the Commission to move carefully, however, lest hasty actions lead to results at odds with its good intentions.

Respectfully submitted,

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What level of dialtone penetration constitutes 'universal service'?

Brooks Albery

This paper focuses on estimating whether a natural level of non-penetration exists, and if so, what the maximum attainable penetration rate is. Universal service penetration levels have steadily increased over the last decade. This paper hypothesizes that penetration levels will level off over time at some point below 100%. Econometric models have been created to estimate penetration rates as a function of several explanatory variables, including per capita personal income, price changes for residential local service, price changes for toll services, and the existence of lifeline programs. The modeling results also provide information on cross-elasticities between toll and local service and the effects of the FCC's subscriber line charges and lifeline programs on the universal service policy goal. In summary, this research provides new information on the topic of what constitutes universal service and provides considerable data regarding own-price and cross-price elasticities associated with residential local service.

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The views expressed in this paper are the author's alone and do not necessarily reflect the views or policy positions of Sprint/United Telephone Company or any of its affiliates. A special note of appreciation is extended to Bob Jacob for help in model specification and estimation and to Vera Blasco for her tireless efforts in accumulating the residential pricing data.

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The concept of universal service has been around since the turn of the century and has arguably been the central policy goal directing telecommunications regulation since its inception. Over the last several decades, policy debates regarding the fate of universal service have become more frequent as regulatory and legal rules have allowed increasing competitive entry into the telecommunications industry.[1] These policy debates will intensify as a connection to the developing information superhighway becomes more and more essential for individuals to participate in today's modern society.

The policy debates have focused primarily on three questions: 'What services are included within the definition of universal service?'; 'How will universal service be funded as the industry migrates away from monopoly toward a competitive structure?'; and 'What level of penetration constitutes universal service?'. Questions regarding the services included within the concept of universal service have increased during the last two decades of rapidly changing technology. The age-old concept of plain old telephone service or 'POTS' evolved very slowly for the first 70 or so years of the industry. As a result of the technological explosion in the electronics industry, initiated ironically by Bell Laboratories' invention of the transistor, POTS has changed dramatically since the 1960s. The pace of technological change affecting dialtone service has continued, and possibly even accelerated up to the present. Current questions about universal service penetration include whether a basket of services should be used to define universal service and the level of technology used to provide dialtone. Examples include questions whether touch tone dialing should be considered part of basic dialtone service, whether dialtone should be provided as a digital rather than analog service and whether dialtone should be provided using an SS7 capable network. As information services become ever more ingrained in our society through the use of personal computers and interactive information services (eg banking at home, the virtual office, etc) questions regarding the definition of the basic level of service will focus on the speed and/or bandwidth at which data can traverse the last

mile of the telecommunications network. Will the latest modem speeds of 28 800 kbps become a benchmark for the error-free capabilities of dialtone? Will ISDN or frame replay capabilities become the benchmark? These questions will be continuously debated as technology expands the capabilities of the telecommunications industry.

The second policy issue, 'How will universal service be funded as the industry migrates to a competitive structure?', is arguably receiving the most attention. Beginning with the introduction of competition into the telecommunications industry and continuing through the divestiture, regulators and the industry have struggled with the problem of sheltering the contribution used to retain low dialtone rates from increasing competitive pressure. The final section of this paper will apply the results of the modeling efforts to this and will provide several policy recommendations.

The third policy issue, 'What level of penetration constitutes universal service?', has been the ugly stepchild of the universal service debates and has received little attention over the years relative to the other two policy questions. In 1910 Theodore Vail wrote that the Bell System was 'founded on broad lines of "One System," "One Policy," "Universal Service" . . . One system with a common policy, common purpose and common action; comprehensive, universal, interdependent, intercommunicating like the highway system of the country, extending from every door to every other door, affording electrical communication of every kind, from every one at every place to every one at every other place'.[2] Based upon this early definition of universal service, the question remained whether 'universal' means from every house to every other house or from every person to every other person. Through either luck or incredible foresight, Vail's early definition may be easily expanded to include personal communication services (PCS) and all other forms of electronic communications. For the purposes of measuring progress toward achieving universal service, however, the industry and regulators have focused on the household as the primary unit of measurement.

The remainder of the paper is composed of three main sections. The first section provides a discussion of historical trends for dialtone penetration and the concept of whether there exists a natural rate of non-penetration. The second section reviews the modeling efforts aimed at shedding light on the questions posed in the first section. The second section also discusses how the modeling results support earlier studies and provide potential guidance on policy issues relating to how dialtone penetration can be increased. The third section applies the modeling results to several of the major policy issues involving universal service and provides suggestions for resolving these policy debates. It is followed by a brief summary and conclusion section.

Is there a natural rate of non-penetration?

The traditional measure of universal service is based upon the percentage of households that have a telephone. This percentage statistic is commonly referred to as penetration.[3] As can be seen in Figure 1, dialtone penetration has increased dramatically over the last 60 years. The pace of increasing penetration, however, has slowed significantly over the last two decades. Figure 2 focuses on the last decade, during which penetration on the national level has steadily, but slowly,

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[1] Some observers of the telecommunications industry believe that the franchise monopolies enjoyed by the Bell System were allowed in exchange for having universal service be the primary goal driving Bell System management. During the 1974 antitrust suit brought against AT&T, support for universal service was argued by AT&T as the primary reason why prior regulatory policies chose a regulated monopoly structure rather than a competitive structure for the telecommunications industry. For more information see Dordick, Herbert 'Toward a universal definition of universal service' *Annual Review of Institute for Information Studies – 1991* 169; and *United States* v *American Telephone and Telegraph Company* 552 F Supp 131 (DDC 1974).

[2] AT&T *Annual Report* (1910)

[3] Another measure of penetration is based upon the number of households that have 'access' to telephones. The analysis presented in this paper utilizes penetration estimates based upon the percentage of households with a telephone. For more information on how penetration has historically been measured and how penetration data are collected, see *Telephone Subscribership in the US* Common Carrier Bureau, FCC, Washington, DC (February 1982).

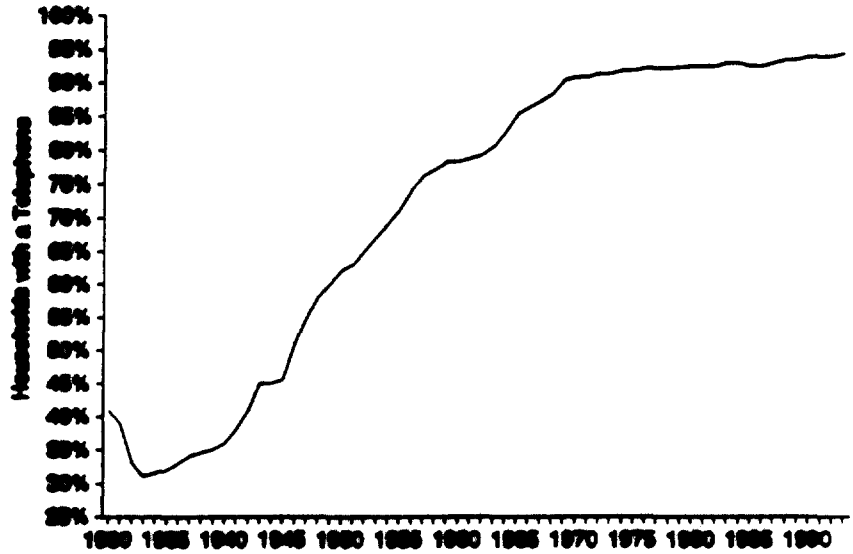

Figure 1. Universal service: residential telephone penetration.

increased. Figure 2 displays the penetration history for the nation as a whole and for the different categories of states: high, medium and low penetration states. The national average penetration data over the period 1984 through 1992 were gathered directly from the FCC's *Trends in Telecommunications* reports. The three state categories represent weighted average penetration levels for five states using total state access lines as weights. The group labeled 'Low Pen. States' consists of the five states with the lowest penetration rates reported in 1985. In a similar fashion, the groups 'High Pen. States' and 'Med. Pen. States' consist of groupings of five states with the highest penetration levels and the middle five states respectively.

Several facts about penetration rates are displayed in Figures 1 and 2. First, Figure 1 appears to clearly indicate that the national dialtone penetration rate is flattening out at a level well below 100%. Second, there is wide variation in penetration levels from state to state. In 1993 penetration levels varied from a low of 87.2% in Mississippi to a high of 97.3% in Pennsylvania. Third, the rate of change in penetration levels varies dramatically between low and high penetration states over the

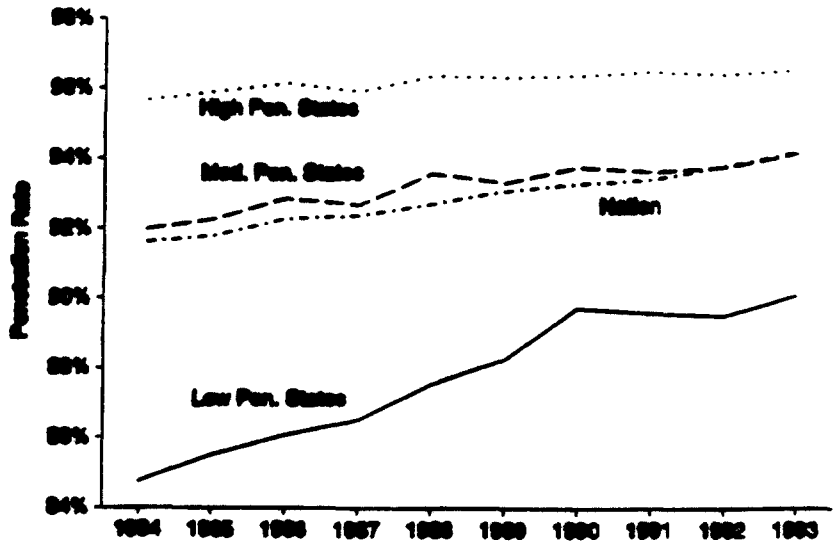

Figure 2. Penetration rate comparisons: high, medium and low penetration states.

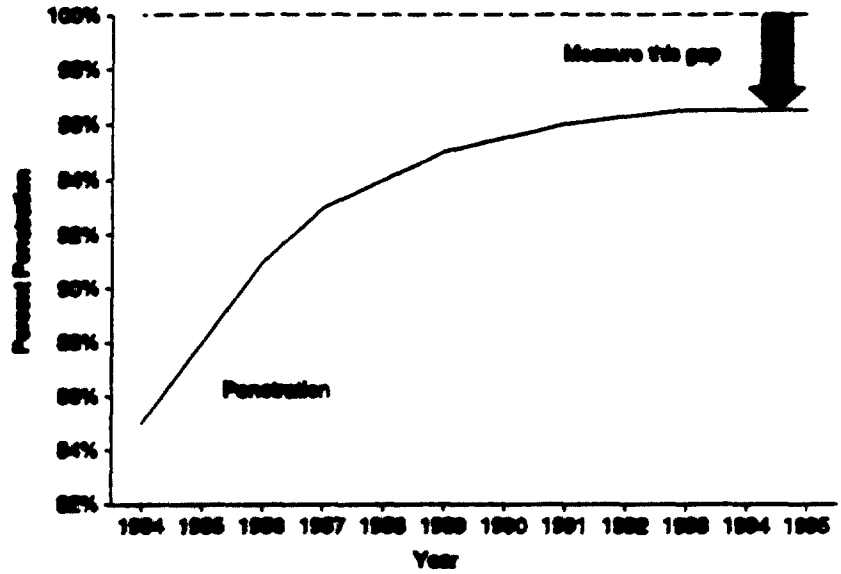

Figure 3. Universal service study.

post-divestiture period. The low penetration grouping identified in Figure 2 enjoyed an increase of over 5% in penetration over the 10-year period. Medium and high penetration states accomplished increases in penetration of only 2.2% and 0.9% respectively. These data strongly indicate that gains in penetration become more and more difficult to achieve as a state's penetration level approaches 100%.

The fact that annual increases in penetration become smaller as states achieve higher levels of penetration is a logical consequence of the definition of penetration. It is impossible to exceed 100% penetration. As such, it is intuitive that the efforts to increase penetration as penetration levels approach 100% will become less and less productive. By way of an extreme example, assume that all households without telephones can be grouped into two classifications: households that cannot afford telephones and households practicing a religion that prohibits telephones. The first group could be cajoled into purchasing telephone service if the proper assistance programs are established or if the group's personal incomes grow to the point where telephone service becomes financially feasible. The second group, however, probably cannot be cajoled into subscribing to telephone service regardless of changes in price, personal income or any factor used to predict telephone subscribership behavior. As in a classic example of diminishing returns, the closer a state's penetration level is to 100%, the less response the state is likely to get through programs to promote telephone subscription.

The primary purpose of this research is to model the relationship between changes in penetration levels over time and the gap between penetration levels and 100%. As is shown in Figure 2, states with low penetration levels have experienced a large increase in penetration over the last decade while high penetration states have seen very little change. It is hypothesized that combining data from all states and specifying a non-linear model for penetration rates will produce a relationship between penetration rates and time similar to the curve depicted in Figure 3. The interesting policy question arising from Figure 3 is whether there exists a 'natural rate' of non-penetration.[4]

There are many factors influencing the decision to subscribe to

[4] A 'natural rate' of non-penetration draws on the economic concept of a natural rate for unemployment. This latter concept posits that, due to, among other things, households moving and the process of businesses folding and opening up, there will be an unavoidable or 'natural' level of unemployment. Stated another way, it is counter-intuitive for 100% employment to ever exist within the labor market due to many different factors. For dialtone penetration, income and religious beliefs are examples of factors which will prevent penetration from ever reaching 100%.

telephone service. Several excellent studies have analyzed this issue. A study by Lewis Perl in 1983 analyzed the effects of local service pricing, a wide variety of demographic characteristics and local calling area characteristics on residential demand for telelphone service.[5] Perl estimated a logit function based upon a huge sample of households obtained from the 1980 census. The results of Perl's study will be compared and contrasted against the results of this study. An important area not researched by Perl's model is the relationship between local service demand and toll prices. During the post-divestiture period, local service pricing, including the FCC's subscriber line charge (SLC), has increased in nominal terms while both interstate and intrastate toll rates have declined rather dramatically. Because basic local service and toll service are complementary products, the decline in toll prices should have had a beneficial effect on subscription rates. A recent study by Jerry Hausman, Timothy Tardiff and Alexander Belinfante (referred to below as the 'HTB' study) has analyzed this issue and found a significant relationship between toll pricing and local service demand.[6] The HTB study used panel data from the Current Population Survey over the period 1984 through 1988 to estimate the effects of several explanatory variables on telephone subscription.

The analysis presented in this paper combines aspects of both the Perl and HTB studies. The model is based upon cross-sectional time series data like the HTB study and includes some demographic variables like the Perl study. The following section presents the results of the modeling effort and compares and contrasts the results with the prior studies. This section also extrapolates the results of the modeling efforts in an attempt to shed additional light on whether a natural rate of non-penetration exists.

Modeling efforts

Specification

Several models of penetration were estimated, with two models providing relatively successful results. The two models are essentially identical except with respect to the dependent variable. In the first model a natural log of the dependent variable was used to provide a non-linear specification. The second model is strictly linear. Several other specifications were tried but provided inferior results. The first model specification (hereinafter referred to as the LOGDEP model) is as follows:

$$LN(PEN) = f(RR1, PIR, LNF, PTOLL, SCLR, CNR) \quad (1)$$

where:

- PEN = telephone penetration rates for each state taken from FCC reports;
- RR1 = deflated statewide average residential dialtone rates within the RBOC territory derived from NARUC, *Bell Operating Company Exchange Service Telephone Rates*;
- PIR = statewide average personal disposable income (1000s);
- LNF = a binary variable reflecting the existence of either the Link-up program or a Lifeline program offered by the RBOC within the state;
- PTOLL = national weighted interstate and intrastate toll price index;

[5] Perl, Lewis J *Residential Demand for Telephone Service 1983* National Economic Research Associates (1983)

[6] Hausman, Jerry, Tardiff, Timothy and Belinfante, Alexander, 'The effects of the breakup of AT&T on telephone penetration in the United States' *AEA Papers and Proceedings* (May 1993)

Table 1. LOGDEP model.

Variable	Units	Coefficient	t-statistic	Statistical significance
Intercept	–	State spec		
RR1	Dollars	-0.002124	-5.87	0.9990
PIR	Dollars	0.002303	1.96	0.9761
LNF	Binary	0.001011	0.91	0.8186
PTOLL	Index	-0.08219	-2.20	0.9866
SLCR	Dollars	-0.001903	-1.70	0.9554
CNR	Dollars	-0.000184	-2.43	0.9925

$R^2 = 0.5125$
$F(6,302) = 52.9$

SLCR = deflated combined interstate and intrastate SLC charges;
CNR = deflated RBOC service connection charges.

Model results

The model was estimated using data from 44 states over the period 1985 through 1992, and the results are presented in Table 1. States were excluded from the sample if no flat-rate service was offered, if the percentage of flat-rate service was excessively small or if no RBOC offered service in the state. The results of the LOGDEP model estimation are quite strong given the high variability of data between states. All coefficients in the final model have the expected sign and, with the exception of the combined Lifeline and Link-up binary variable, are significant at the 95% level or above. Several prior iterations of the model showed that the data could not support separate interstate and intrastate toll price indices and SLC charges. Combining these variables into the PIR and SLCR variables significantly improved the modeling results. In a similar fashion, separate Lifeline and Link-up binary variables provided less significant results than the combined LNF variable.

The model results for flat-rate residential service, service connection charges and toll pricing are consistent with prior studies. The deflated RBOC flat-rate residential service price variable (RR1) proved significant at the 99% level. Using the model results, an estimated price elasticity of -2.65 was calculated.[7] This elasticity estimate is very consistent with the price elasticity of -3.2 estimated in the Perl study. The Perl study estimated price elasticities which varied considerably across geographic areas depending upon the level of penetration in the areas. Areas with high penetration displayed considerably lower price elasticities. This, again, is consistent with the fact that penetration cannot exceed 100% and that some natural level of non-penetration exists. Given this analysis within the Perl study, a lower elasticity estimate from later studies is expected as national penetration levels have increased significantly since 1980 (which is the year the data set was collected for the Perl study). Thus the price elasticity of -2.65 is consistent with both the level of elasticities generated in the Perl study and the likely trend of changes in elasticities indicated by Perl's results.

The coefficient for the combined and deflated interstate and intrastate SLC charges was also significant. To a large degree, the success of the modeling efforts hinged on successfully including the SLC charges within the model. As SLCs are perceived by end users as increases in basic local service rates, the SLC charges either had to be included within the RR1 variable and show up in the model data as increases in

[7] All elasticities are presented in percentage form. Thus this elasticity indicates that a 10% increase in dialtone price results in a -0.265% decline in dialtone demand.

the RR1 rate, or the state and federal SLCs had to appear as separate variables. However, since the federal SLC program was accompanied by reductions in LEC access rates and IXC toll prices, in order to evaluate the combined effects of rising basic dialtone rates associated with the SLC programs and the falling toll rates it was important to include a separate SLC variable in the model. Early model runs contained separate interstate and intrastate SLC variables. Due to the relatively few states that have intrastate SLC rates, however, the model with separate SLC variables failed to perform well. The combined and deflated SLC variable was estimated with a 95% statistical significance.

The service connection charge (CNR) variable was also very significant within the model. The cross-elasticity between the CNR and dialtone demand estimated by the model is –0.83. This estimate compares with elasticity estimates of –0.97 in the Perl study and –2.06 in the HTB study. The CNR estimate from the model is, again, very consistent with the Perl study results in terms of both size and trend (expecting a smaller elasticity as overall national penetration increases). It is unclear why the HTB study produced a higher elasticity estimate, but differences in both specification and the years used in the studies probably account for the differences. The results of the Perl study indicated that local service demand is more sensitive to changes in installation prices than changes in monthly access rates.[8] This result is surprising and explains why several universal service support programs are aimed at reducing the impact of service connection charges on penetration rates.

The coefficient for the combined interstate and intrastate toll price variable was also very significant, with a t-statistic above 2. Several model runs were attempted with separate interstate and intrastate toll price indices, but these models produced unsatisfactory results. The cross-elasticity between residential dialtone demand and toll pricing estimated by the model is –3.7. Again, this result compares favorably with the HTB study which estimated toll cross-elasticities of –0.27 for intra-LATA toll rates, –0.86 for intrastate inter-LATA toll rates and –0.19 for interstate inter-LATA toll rates. While the elasticity from the LOGDEP model is larger than the elasticities from the HTB study, the HTB elasticities are far more disaggregated than the LOGDEP elasticity.

The coefficient for statewide average personal disposable income also came in quite significant, and the income elasticity of demand is consistent with the Perl study. The Perl model estimated an income elasticity of 1.91 while the elasticity from the LOGDEP model is 2.96. The results of the Perl study clearly indicate that household income levels are a primary driver behind the telephone purchasing decision. The results of this study confirm this by showing a strong correlation between statewide average personal income levels and statewide measurements of telephone penetration. The Lifeline programs designed to provide pricing relief for lower-income households are also directed toward this relationship. Given the strong relationships between service pricing, personal income and telephone penetration, it is interesting that the binary variable representing the Lifeline and Link-up programs failed to enter the LOGDEP model significantly. The coefficient for the LNF variable has the correct sign but is relatively low on statistical significance. An intuitive reason for the failure of this coefficient is the very low subscription to the Lifeline and Link-up

[8] Hausmann *et al*, *op cit* Ref 6, 16. One potential explanation for Perl's results is the inclusion of local measured rate elements within the Perl model. It is possible that the relatively lower monthly fixed prices associated with measured service produced lower price sensitivity for access demand. An obvious area for future study with the modeling efforts presented in this paper will be to include a variable for measured rate dialtone service within the model specification.

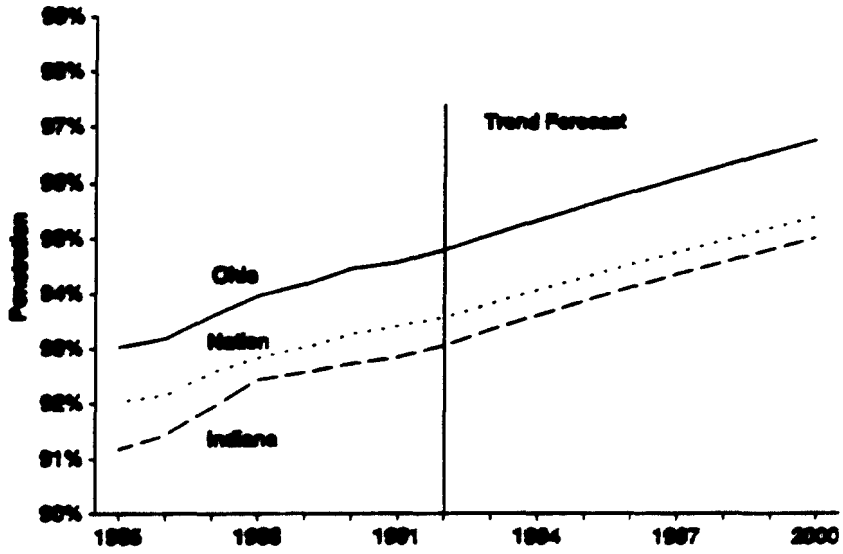

Figure 4. Penetration model: LOGDEP specification.

programs by the portion of the customer base eligible for these programs.[9]

Figure 4 graphs estimates from the LOGDEP model for the states of Ohio and Indiana and for the national average over the range of the data and provides a trend forecast over the period 1993 through 2000. One aspect of the LOGDEP model that is disappointing is the degree of non-linearity between penetration and the explanatory variables. As can be seen in Figure 4, the trend forecasts are very nearly linear and certainly do not display as asymptote below 100%. Under a separate analysis using the model results and zeroing out all variables with negative coefficients while trend growing positive coefficient variables shows penetration increasing above 100% prior to the year 2000. This result indicates that either the data set is not rich enough to estimate the natural rate of non-penetration or the model specification is not adequate for ferreting this information out of the data. A quick look at Figure 1 implies that a data set from 1930 through 1993, if it could be constructed, would probably provide better results regarding the question of whether there exists a natural rate of non-penetration. Changes in the definition of penetration over this period along with the limited historical scope of the NARUC RBOC pricing guides would make the data collection effort for this expanded study effectively impossible.

An alternative method used to determine whether the non-linear modeling relationship is appropriate was to estimate a linear specification and determine which model provides a better fit for the data. To accomplish this, a linear model (LINMOD) was estimated using the same set of explanatory variables and non-log transformed penetration data for the dependent variable. The results of this model are presented in Table 2.

A quick review of the two models' results shows that the estimation results are identical for all practical purposes. This result further reinforces the conclusion that data over the period 1985 through 1992 are not rich enough to estimate whether a natural asymptote exists for penetration. Prior to leaving this discussion, it is worth noting that several specifications which force an asymptote of 100% were estimated. Specifically, a model with the dependent variable (1/(1–PEN) was estimated with poor results. This dependent variable explodes as

[9]There are several reasons for the relatively low participation in Lifeline assistance programs. First, after the programs are implemented, awareness of the existence of the programs tends to decline. Also, churn in the customer base with families moving into and out of a LEC's territory causes high administrative costs for keeping the customer base informed of the programs. For a more complete treatment of Lifeline programs, see Johnson, Leland *Telephone Assistance Programs for Low-Income Households* R-3603-NSF/MF, Rand Corporation, Santa Monica, CA (1988).

Table 2. LOGDEP.

Variable	Units	Coefficient	t-statistic	Statistical significance
Intercept	–	State spec		
RR1	Dollars	−0.001939	−5.63	0.9990
PIR	Dollars	0.002125	1.95	0.9744
LNF	Binary	0.000809	0.79	0.7852
PTOLL	Index	−0.030917	−2.26	0.9881
SLCR	Dollars	−0.001827	−1.76	0.9606
CNR	Dollars	−0.000162	−2.31	0.9896

R^2 = 0.5167
F(6,302) = 58.8

Table 3. Historical trend and policy analysis: Ohio.

Variable	Delta variable (1985–92)	Delta penetration (predicted)	Delta lines (predicted)
RR1	−4.270	0.00911	29 155
PIR	0.982	0.00229	7 317
LNF	1.000	0.00101	3 237
PTOLL	−0.243	0.00785	25 120
SLCR	1.745	−0.00332	−10 610
CNR	−9.720	0.00179	5 728
Total predicted delta		0.01873	59 948
Total actual delta		0.024	76 802
Unaccounted for delta			16 853

Table 4. Historical trend and policy analysis: Indiana.

Variable	Delta variable (1985–92)	Delta penetration (predicted)	Delta lines (predicted)
RR1	−6.020	0.01287	21 719
PIR	1.336	0.00308	5 201
LNF	1.000	0.00101	1 707
PTOLL	−0.243	0.00785	13 249
SLCR	3.127	−0.00593	−10 013
CNR	−8.230	0.00152	2 558
Total predicted delta		0.02039	34 421
Total actual delta		−0.004	−6 751
Unaccounted for delta			−41 172

Table 5. Historical trend and policy analysis: national average.

Variable	Delta variable (1985–92)	Delta penetration (predicted)	Delta lines (predicted)
RR1	−3.210	0.00684	711 912
PIR	1.135	0.00262	272 449
LNF	1.000	0.00101	105 258
PTOLL	−0.243	0.00785	816 870
SLCR	1.790	−0.00340	−353 865
CNR	−13.69	0.00252	262 454
Total predicted delta		0.01744	1 815 078
Total actual delta		0.020	2 081 208
Unaccounted for delta			266 130

PEN → 1 and the model results broke down under this specification. This specification is intuitively appealing, however, in that the closer a state is to 100% penetration, the smaller the impacts of changes in the explanatory variables on the penetration rate.

Tables 3, 4 and 5 provide estimates of changes in basic local service demand within Ohio and Indiana and for the nation as a whole generated by the LOGDEP model using historical changes in the explanatory variables over the period 1985 through 1992. The analyses presented in these tables are very rough but are useful for discussing policy options and the relative effects of changing conditions within the

geographic areas on overall penetration levels. The analyses apply estimated changes in penetration to total Bell lines within the geographic areas for 1992. The 'actual delta' presented in the analysis is generated by multiplying the change in actual penetration rates over the period 1985 through 1992 times Bell access lines in 1992. Thus this analysis is static to 1992 and is useful for comparing actual to predicted penetration rates. In reality, actual changes in Bell lines over the period reflect changes in the economy and growth in the customer base in addition to changes in penetration.

Tables 3, 4 and 5 also present some interesting policy discussions. The variable producing the largest change in demand for basic dialtone in Ohio and Indiana is RR1. The deflated (1987 dollars) residential dialtone rate declined by $4.27 in Ohio and $6.02 in Indiana. The national average dialtone rate fell by $3.21 over the period. The falling residential dialtone rates accounted for roughly 33% of the increase in subscriber penetration nationally.

The combined interstate and intrastate toll price index provided the second largest impact on penetration. At the national level, 38% of the increase in penetration is attributable to declining toll prices. Related to changes in the toll price index is the creation of the SLC program. As the FCC's SLC rates were designed to offset the revenues LECs formerly acquired through switched access rates, the increases in SLC charges and revenues were directly related to decreases in switched access rates. Due to competitiveness in the long-distance industry, the declining switched access rates were quickly reflected in declining toll rates.[10] As noted above, the SLC rates were estimated with a high level of statistical significance in the LOGDEP model. The estimated impact of the SLC programs on penetration generated by the LOGDEP model indicates that dialtone repression from SLCs is roughly half of the dialtone stimulation associated with falling toll rates. In Indiana, SLC repression is higher due to the existence of an intrastate SLC element. Presumably, the lower switched access rates in Indiana generated by the intrastate SLC charge would produce a steeper decline in intrastate toll prices and a higher stimulation of dialtone demand from toll rate increases. Unfortunately, the LOGDEP model uses national average interstate and intrastate toll price indices which are unable to capture this effect.

A logical conclusion from the estimated SLCR and PTOLL coefficients is that the SLC program, through its effect on the toll market, served to increase residential dialtone penetration. This result is directly consistent with the findings in a 1989 study by Southwestern Bell economists.[11] The Southwestern Bell study analyzed customer bills before and after implementation of the SLC charges and concluded that reductions in residential toll bills associated with declining toll rates more than offset increases from the SLC. While the portion of toll price reductions caused directly by the SLC program is subject to debate, toll price reductions over the period 1985 through 1992 were sufficient to more than overcome the repressive effects of SLCs. This result is further confirmed by the LOGDEP model.

The service connection charge variable (CNR) provided a less significant source of stimulation. At the national level, declining CNR rates (in real terms) produced roughly 12% of total stimulation. In Ohio and Indiana, due to less dramatic declines in service connection rates, the CNR-sponsored stimulation was 8% and 6% respectively.

[10] A recent paper on this topic shows that per minute toll prices have historically declined faster than per minute reductions in access costs. The analysis presented in this paper indicates that the competitive toll industry appears to have experienced increased internal efficiency and has passed through all access savings created from falling access rates. For more information see Stevens, Mark 'Should the interLATA restriction be lifted? Analysis of the significant issues' Paper presented at the Rutgers University Advanced Workshop in Regulation and Public Utility Economics, Seventh Annual Western Conference, 6–8 July 1994.

[11] Larson, Alexander, Mitarewicz, Thomas and Monson, Calvin 'The effect of subscriber line charges on residential telephone bills' *Telecommunications Policy* 1989 13 (4) 337–354